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INTERIM REPORT:
STUMPING DEMONSTRATION TO CONTROL
ARMILLARIA ROOT DISEASE ON THE BONITO DIVERSITY UNIT,
JEMEZ RANGER DISTRICT, SANTA FE NATIONAL FOREST

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STUMPING DEMONSTRATION TO CONTROL ARMILLARIA ROOT DISEASE ON THE BONITO DIVERSITY UNIT, JEMEZ RANGER DISTRICT, SANTA FE NATIONAL FOREST

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ABSTRACT

An integrated forest protection demonstration to control Armillaria root disease by stump removal in three units of the Bonito Timber Sale began in 1992. Trees from these three units had previously been removed using clearcut, overstory removal, and group selection treatments. Each unit was divided into thirds by the number of stumps and the distribution of stumps by diameter class. A different intensity of stump removal (no, partial, and complete) was randomly assigned to each third. Stumps were either excavated, pulled, or excavated and pulled in all complete stumping areas and in two of the three partial stumping areas. It took 30 seconds to one minute to remove a 12-inch diameter stump and 5 minutes to 30 minutes to remove a 30-inch diameter stump. The average time for removal was approximately the same for the three methods until stump diameter was greater than 30 inches, then the excavation method was fastest. Stump pulling was more costly than excavation but there was less damage to the site and root systems were relatively clean after stumps were pulled. Seventy-five percent of the residual trees survived after stumping in the overstory-removal unit. The selection of equipment used to operate the puller was effective but inefficient and expensive. Recommendations have been made to improve stump-removal efficiency.

INTRODUCTION

In 1984, an out-of-court settlement (as part of an action to prevent the broadcast spraying of pesticides for western spruce budworm control) required that integrated forest protection demonstration areas be established to explore silvicultural alternatives to manage forest pests. Stands were selected within the Bonito Diversity Unit of the Jemez Ranger District, Santa Fe National Forest, for the demonstration. Part of the demonstration included a long-term study to determine the effects of stump removal on stand productivity in areas severely infected with Armillaria root disease.

A 10 percent strip cruise of 500 acres of the Bonito Diversity Unit (compartment 317.1) showed that approximately 10, 12, and one percent of sawtimber, saplings, and seedlings, respectively were killed by Armillaria and two percent of the area (9.9 acres) was occupied by active root disease centers and out of timber production (Wood, 1982). In 1987, 39 transect lines (Bloomberg survey) covering the same 500 acres determined that between 189 and 240 acres were within active root rot centers (Schultz and Kalaforski, unpublished report). Because Armillaria root disease was attacking all conifers (blue spruce, Douglas-fir, limber pine, ponderosa pine, and white fir) in this area as well as aspen, Forest Pest Management specialists, Rocky Mountain Research Station scientists, and Santa Fe National Forest foresters recommended the stumping study.

One objective of this demonstration was to determine how well Armillaria could be controlled using three different stand treatments (clearcut, group selection, and overstory removal) and two different intensities of stump removal (new and old[1] [complete], or just new stumps [partial]). Another

[1] Old stumps are stumps 3 years and older. New stumps were stumps created as a result of the 1991-92 logging and stumps created as the result of snag removal over the last two years.

objective was to determine the effect of stumping on the residual stand. A third objective was to determine which method of stump removal left the least soil on removed root systems with minimal site disturbance for the least cost.

METHODS

Three of the 18 timber sale units of the Bonito Timber Sale (ranging in area from 8 to 46 acres) were chosen for the stumping study. Trees were removed from these three units in the winter of 1991-92. Boundaries of each unit were transect-measured to determine their shape and area. The clearcut unit (13.2 acres) was divided into roughly equal thirds (by the number of stumps in each diameter class) and each third was randomly assigned a treatment (control - no stumps removed, partial stumping, and complete stumping). After the division was made, each third was compared for the number and size of stumps. There were approximately equal numbers of stumps in each class for each third. For the group selection unit (1.5 acres) and the overstory removal unit (17.9 acres) the area was first sectioned into two chain strips and the stumps counted and classified by diameter within each strip. This data was used to divide each of these units into equal thirds (based on stump counts) and each third randomly assigned one of the three treatments as was done for the clearcut unit.

A time-and-motion study was conducted to analyze the efficiency of removing stumps of various diameters using a Foster FNV-1000 Vibro-Driver/Extractor (puller) (figure 1), or an excavator (John Deere, model 690-B) (figures 2 and 3).

In the overstory removal unit a total of sixteen 1/50 acre plots were established (at 2 X 2 chain intervals) to determine the effect of stump removal on the residual stand.

RESULTS

Of the 688 new and 188 old stumps removed 598 new and 127 old stumps were removed during the five weeks of stumping in 1992. A total of 90 new and 17 old stumps were removed in the three days of stumping in 1993 (table 1).

One-hundred-ten, and 60 new stumps were excavated, and pulled, respectively, for the time-and-motion study. It took approximately the same time using either method to remove new stumps less than or equal to 30 inches in diameter (figures 4 and 5). For new stumps greater than 30 inches excavation was the quickest method. There was a large variation in the time it took to pull or excavate old stumps. Though there was a relationship between stump size and the time to pull or excavate old stumps, the soundness of the root system was the most important factor for the time it took to remove stumps. No comparison between stump age and the pulling or excavation time was made. Most old stump could be extracted in less than 90 seconds.

Soil stuck to root systems that were excavated (figure 6) but very little soil was left on root systems of pulled stumps (figure 7).

Twenty-five percent of residual trees within the 1/50 acre plots in the overstory unit were uprooted or killed by the stump removal operation, though this loss did not appear to adversely affect stocking.

Table 1: The number of stumps removed in complete and partial treatment areas of the clearcut unit (unit 16), the overstory removal unit (unit 17), and the group selection unit (unit 32) for each diameter class (the number of old stumps are in parenthesis).

			Stump Diameter (in)					
Unit	Treatment	Stump Type	0-6	6.1-12	12.1-18	18.1-24	24+	Total
16	partial	new	3	86	50	43	14	196
16	complete	new	14	84	47	20	22	187
16	complete	(old)		(7)	(20)	(22)	(21)	(70)
17	partial	new	10	32	29	28	30	129
17	complete	new	2	41	27	22	44	136
17	complete	(old)		(9)	(9)	(16)	(31)	(65)
32	partial	new		2	1	6	10	19
32	complete	new	1	5	10	2	3	21
32	complete	(old)	(1)	(5)	(3)			(9)
Total		new	30	250	164	121	123	688
		(old)	(1)	(21)	(32)	(38)	(52)	(144)

The average diameter of new stumps removed was 15.5 inches. Day-to-day records for the number of stumps removed in one day was best determined using data acquired during the last week of stumping in 1992. In that period, 20 new and 10 old stumps were removed per seven hour day or 14 minutes per stump (removal, travel time, and down time). The average new stump diameter was 26 inches for this period and the average travel time between stumps was 1 minute 50 seconds. The average time used to pull, excavate, or excavate and pull new stumps was 9.5 min. The average removal and travel time was approximately 11.5 minutes. Two and one-half minutes (14 minus 11.5) per stump or 75 minutes per seven hour day was the average down time.

The total cost for stumping in 1992 was $43,696 or $60.27 per stump. The cost of stumping in 1993 was $2,830 or $26.20 per stump. Unit 16 (487 stumps removed) cost approximately $4,173 per acre to stump.

1992 Costs	Excavator and Loader rental and operation	$27,193
	Stump puller and power unit rental and transport	8,420
	Salary (administration and project maintenance)	7,400
	Supplies (hydraulic hoses and hydraulic fluid)	417
	Vehicle costs	266
1993 Costs	Excavator rental and operation	$ 2,080
	Salary and Misc. (administration)	750
	Total	$45,526

DISCUSSION

The puller worked well on shallow rooted stumps, stumps that cracked during the pulling, and on small diameter stumps (less than 24 inches in diameter). The extractible below-ground biomass (weight) increased logarithmically with the stump diameter at ground line (Omdal and Shaw, unpublished). Stumps larger than 24 inches increased in weight with each increase in increment (they represented the steepest rise in weight) much greater than stumps from 10 to 24 inches. Stumps over 24 inches also were harder to split. The large stumps were easier to remove using the excavator. Care had to be taken to remove roots from the dirt as it was piled to prevent large root pieces from being put back into the hole caused by excavation. If infected root pieces were reburied they would serve as inoculum. If large, uninfected roots were reburied they might be colonized and also serve as inoculum. Saplings and seedlings within 10 feet of a large stump were uprooted and killed during excavation because the root ball of a large stump usually extended out that far. When a clean root system was required for recording the number of root infections, it took several hours to clean the larger excavated stumps (figure 8)(the time needed to clean stumps was not recorded). Pulled stumps required little if any hand cleaning prior to detailed data recording. The time it took to clean stumps should be used to compare methods of stump removal if root systems have to be clean for examination or for disposal by burning. There was less site disturbance with the puller except when the puller was unable to be lowered over a stump (because of nearby saplings).

The power unit used to operate the puller was moved between stumping locations by the excavator (figure 9). This prevented, in several instances, a smooth transition between stumps. The five hydraulic lines that operated the puller frequently snagged on slash and kinks in the lines caused undue wear. The fittings used to attach these lines to the puller and power unit were unnecessarily stressed when the lines were dragged between stumps and when the grapple released a pulled stump. When the hydraulic lines had to be removed from the power unit or when the fittings loosened while moving the equipment, the valve that directed the two-way flow of the hydraulic fluid to the grapple would stick in one position and the jaws could not be closed. Suspending the puller from the bucket of a loader caused problems in safety, difficulties in positioning [of] the puller, and unusual wear on the loader (figure 10).

The 9.5 minutes per stump for removal was over four times greater than it took to remove ponderosa pine stumps in Washington state (Russell, 1981). The average cost of removal per stump ($60.27 in 1992, $26.20 in 1993) was considerably greater than for the Washington study ($2.60). Only the stumps successfully removed by the puller were used in the Washington time-and-motion analysis (Schiess and Chang, 1982). Stumps that did not pull within five minutes were considered unsuccessful attempts and not included in their analysis, thus a direct cost comparison can not be made. Though they determined quickly whether a stump could be pulled or not 25% of the time was spent on unsuccessful attempts. The average diameter of successfully pulled stumps was 17 inches; the average diameter of unsuccessfully pulled stumps was 25 inches. Less than 50% of the stumps were pulled with diameters greater than 26 inches. We attempted and eventually pulled several stumps over 30 inches in diameter. The time it took to pull the large stumps greatly increased the total cost of stumping. The additional time needed to pull stumps for this study was also the result of the type of root system compared to the root systems of

trees in the Pacific Northwest. Only 30% of the Washington study root system were classified as lateral types the other 70% were classified as normal or carrot types. The lateral type of root system took the longest to pull. Most of the larger root systems in this study appeared to be lateral.

The stumping of another overstory removal unit was intended as part of the study plan but was canceled due to cost of stumping and the severity of dwarf mistletoe infection in the remaining advanced regeneration.

RECOMMENDATIONS

The loader used to operate the puller did not have the lifting height or counter-weight to pull some of the larger stumps. Also, its' rubber tires sunk deeper into the soil and appeared to compact it more than the tracks of the excavator (especially in the low areas). If the power unit was mounted on the rear of a track vehicle that also does the pulling then it would have more counter-weight, additional personnel would not be needed to move the hydraulic lines, there would be less damage (and subsequent down time) to these lines, and there would probably be fewer hydraulic valve problems. A narrow wheel base crane may be the best piece of equipment for vibro-stump pulling because it would have the lifting height and power and would be able to maneuver between trees without compacting the soil and damaging the residual stand. The one advantage of the loader that may not be possible with a crane is that it was hinged in the center between the axles. This feature allowed the loader to turn easily. The excavator turned by braking and/or reversing the motion of one track. This action caused the rear end to swing out and damage residual trees on the outside of the turn. We suggest that personnel from the Forest Service Equipment Development Center, in Missoula, Montana, be involved in any future trials.

Although unit 18 is no longer part of this stumping demonstration, we recommend that additional sanitation thinning be conducted within this unit to reduce the high levels of dwarf mistletoe in the residual trees and to improve the health and vigor of this stand. This is a proven silvicultural option for pest management.

ACKNOWLEDGEMENTS

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Figure 1. A section of a stump being held in the grapple of the vibro-stump puller (orange). The puller is being operated from a rubber-tired front-end loader (yellow).

Figure 2. Small stump being excavated.

Figure 3. A 36-inch diameter stump that was completely trenched to break and remove large roots prior to pulling.

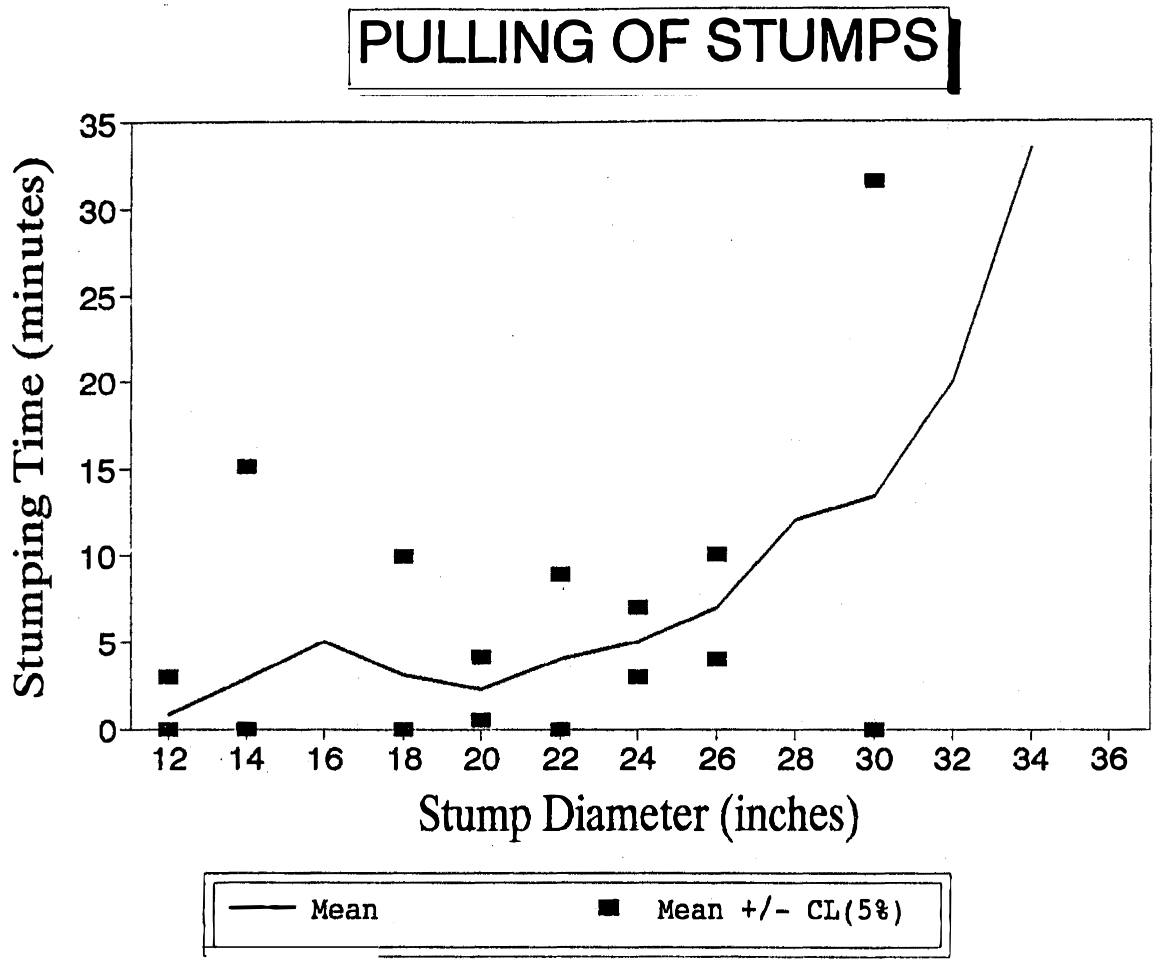

Figure 4. The mean time by diameter class for pulling stumps in 1992.

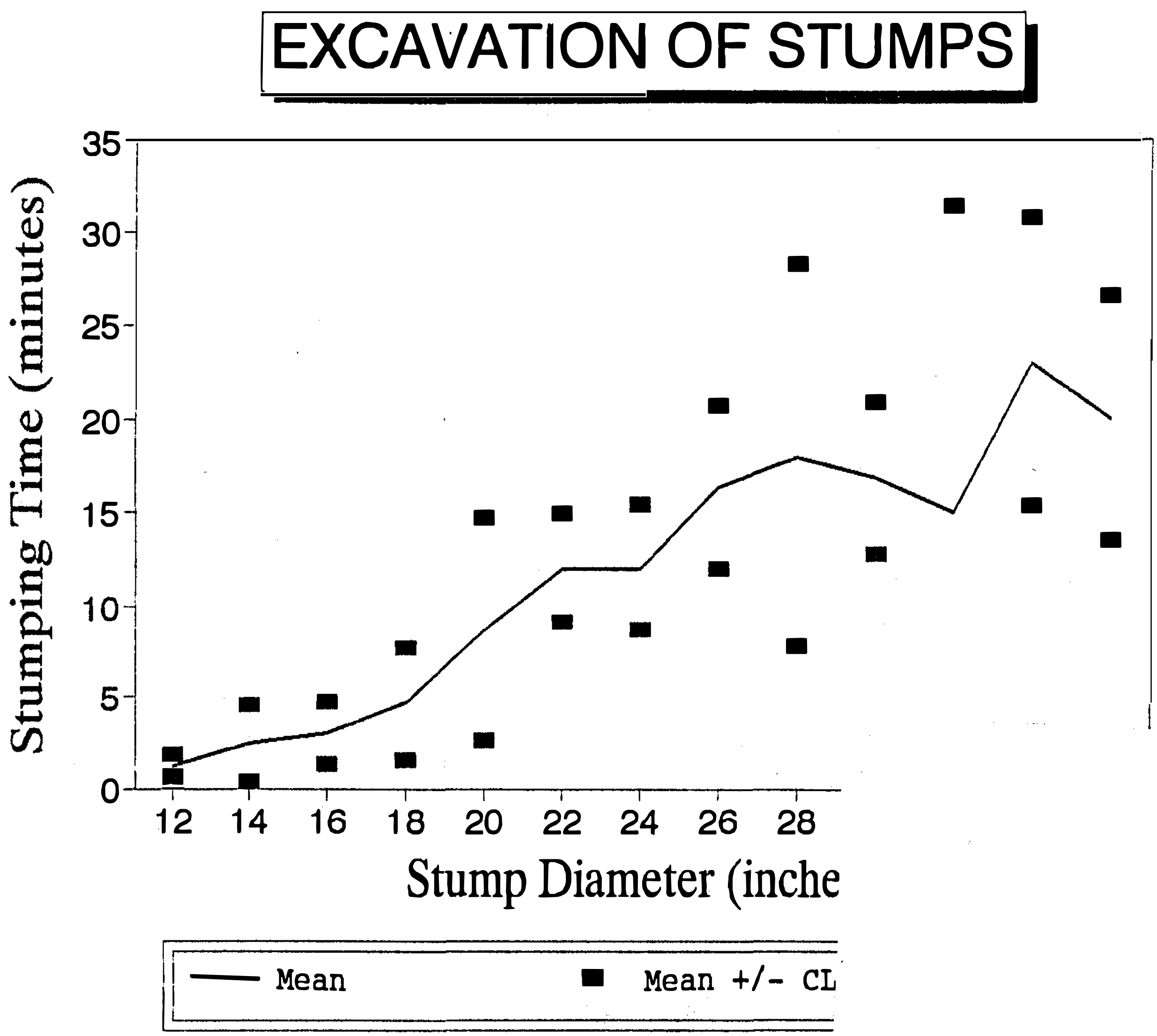

Figure 5. The mean time by diameter class for excavating stumps.

Figure 6. The root system of a large stump that was excavated.

Figure 7. The root system of a stump that was pulled by the vibro-stump puller.

Figure 8. The cleaning of soil from around the roots of a stump that was excavated.

Figure 9. The diesel power unit that provided the hydraulic power to the vibro-stump puller.

Figure 10. The vibro-stump puller suspended from the front-end loader by a cable.

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